RS-FEC Frame Error Rate (Comment #302)

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Some background

- The main purpose of specifying PHY-level error rates is to achieve a sufficiently low packet error rate
- A certain packet error rate should be an objective for a PHY, set by higher layer requirements/expectations
- PHY people are familiar with 10^{-12} upto 10^{-10} BER values, especially for binary SERDES solutions without FEC
  - Largely limited by testability complication
  - Note that without FEC every bit error corrupts a packet
  - For packet lengths of 10-100kbits, these BERs imply a packet error rate of 10^{-7} to 10^{-6}
- System expectations of (virtual) BER < 10^{-15}
  - On average less than one failed packet per 10^{15} 'source' bits
  - This is what previous PHY technologies have practically provided

Ethernet case

- Standard Ethernet frames are 72-1530 bytes long, including preamble and FCS, excluding 12-byte IFG
- Coding overhead factor 360/325*65/64=9/8
- Short: 72+12 = 84 bytes = 672 ‘source’ bits
  - 672*9/8 = 84*9 = 756 line bits = 378 PAM4 symbols
- Long: 1530+12 = 1542 bytes = 12344 ‘source’ bits
  - 12344*9/8=1542*9=13878 line bits = 6939 PAM4 symbols
- Jumbo: ~100k ‘source’ bits
- RS-Frame = 3600-14400 bits = 1800-7200 PAM4 symbols
- RS-Frames don’t align with packets, so a single frame errors can corrupt multiple packets

Bytes - Bits – Packets - Frames

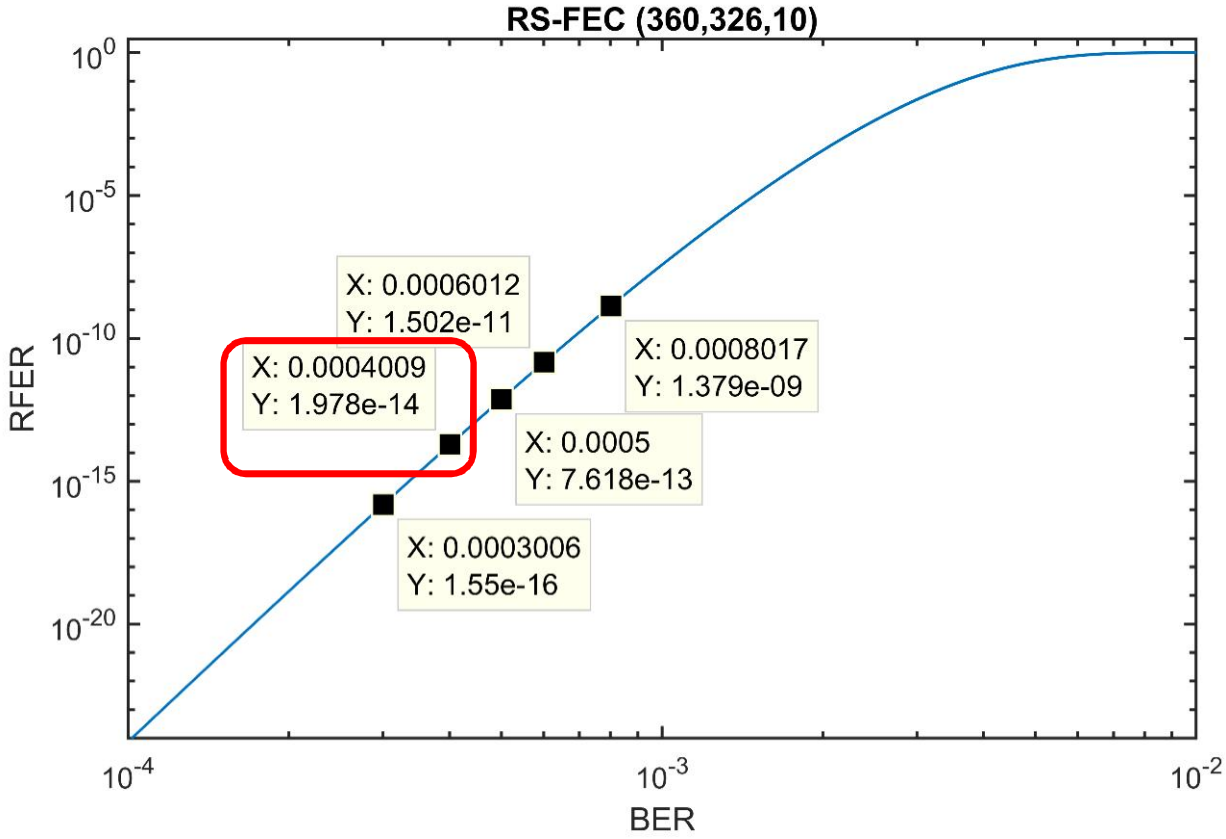
	Short	Long	Jumbo
Source bytes	84	1542	
Source bits	672	12344	~100000
Coded bits	756	13878	
Coded symbols	378	6939	
Packets/Frame (L=1)	4.76	0.26	
Packets/Frame (L=2)	9.52	0.52	
Packets/Frame (L=4)	19.05	1.04	

- A broken RS-Frame will corrupt the whole Super-Frame
- Up to 20 short packets in a RS-SuperFrame
  - a single RS-Frame Error can kill up to 20 packets
- Down to 4-5 RS-Frames for a single packet
  - a single RS-Frame Error can kill 1-2 packets

Desired RFER value

- If RFEC < $8/9 \cdot 3600/20 \cdot 10^{-15} = 1.6 \cdot 10^{-13}$, the number of failed packets will be on average less than for a PHY without FEC and a BER of 10^{-15}
  - With FEC multiple packets can get corrupted by one frame error

BER-RFER relation for MGBASE-T1



- RS-FEC makes curve very steep: BER deltas are small
- Implies RFER will either be inmeasurable small or horrible
- Better select an RFER value on the safe side: suggest $2 \cdot 10^{-14}$

Testability

- With an uncorrected-BER of $< 4 \cdot 10^{-4}$ there will practically be no errors above the FEC due to random error sources
- But RFER $< 2 \cdot 10^{-14}$ will be hard to measure directly
  - at 10Gbps the MTBF will be 7 months
  - at 2.5Gbps the MTBF will be 2.3 years
- However the RS-Symbol Error Rate (pre-FEC) can be used as measure for expected RFER
  - RSER is easy and quick to measure
  - Provides RFER estimate assuming random gaussian error sources

Proposed solution

- Remove RFER requirement
- Add an RS-Symbol Error Rate (RSER) of < $4 \cdot 10^{-3}$

End